

1 ~~5214~~. (amended) A method of treating a coal formation in situ, comprising:

- allowing heat to transfer from heat sources to a part of the formation such that the heat from the heat sources pyrolyzes some hydrocarbon material in the part of the formation;
- producing pyrolysis products from the formation;
- heating a first section of the part with one or more of the heat sources to a temperature sufficient to allow generation of synthesis gas;
- providing a first synthesis gas generating fluid to the first section to generate a first synthesis gas;
- removing a portion of the first synthesis gas from the formation;
- heating a second section of the part with one more of the heat sources to a temperature sufficient to allow generation of synthesis gas having a H₂ to CO ratio greater than a H₂ to CO ratio of the first synthesis gas;
- E1 providing a second synthesis gas generating fluid to the second section to generate a second synthesis gas;
- removing a portion of the second synthesis gas from the formation; and
- blending a portion of the first synthesis gas with a portion of the second synthesis gas to produce a blended synthesis gas having a selected H₂ to CO ratio.

2 ~~5215~~. (amended) The method of claim ~~5214~~, wherein superposition of heat from at least two of the heat sources pyrolyzes at least some hydrocarbons in the part of the formation.

3 ~~5216~~. (amended) The method of claim ~~5214~~, wherein the first synthesis gas generating fluid and the second synthesis gas generating fluid comprise carbon dioxide.

4 ~~5217~~. (amended) The method of claim ~~5214~~, further comprising controlling the temperature in the first section to control a composition of the first synthesis gas.

5 ~~5218~~. (amended) The method of claim ~~5214~~, further comprising controlling the temperature in the second section to control a composition of the second synthesis gas.

¹⁴
5227. (amended) The method of claim 5214, further comprising providing at least a portion of the produced blended synthesis gas to a methanol synthesis process to produce methanol.

¹⁵
5228. (amended) The method of claim 5214, further comprising providing at least a portion of the produced blended synthesis gas to a gasoline synthesis process to produce gasoline.

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5229. (amended) The method of claim 5214, wherein removing a portion of the second synthesis gas comprises withdrawing second synthesis gas through a production well, wherein a temperature of the production well adjacent to a production zone of the second synthesis gas is maintained at a substantially constant temperature such that the H₂ to CO ratio of the second synthesis gas is greater than the H₂ to CO ratio of the first synthesis gas.

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5230. (amended) The method of claim 5214, wherein the first synthesis gas producing fluid comprises CO₂ and wherein the temperature of the first section is at a temperature that will result in conversion of CO₂ and carbon from the first section to CO to generate a CO rich first synthesis gas.

¹⁸
5231. (amended) The method of claim 5214, wherein the second synthesis gas producing fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons react in the formation to increase a H₂ concentration in the produced second synthesis gas.

¹⁹
5233. (amended) The method of claim 5214, further comprising removing an excess of first synthesis gas from the first section to have an excess of CO, subjecting the first synthesis gas to a shift reaction to reduce an amount of CO and increase an amount of H₂ before blending the first synthesis gas with the second synthesis gas.

²⁴
5237. (amended) The method of claim 5214, further comprising generating electricity from the blended synthesis gas using a fuel cell, separating carbon dioxide from a fluid exiting the fuel cell, and storing a portion of the separated carbon dioxide in a spent section of the formation.

5239. (amended) The method of claim 5214, wherein allowing the heat to transfer from the heat sources to the part of the formation increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part is substantially uniform.

5240. (amended) The method of claim 5214, wherein allowing the heat to transfer from the heat sources increases a permeability of a majority of the part to greater than about 100 millidarcy.

E5 5241. (amended) The method of claim 5214, further comprising heating the first section when providing the first synthesis gas generating fluid to inhibit temperature decrease in the first section during synthesis gas generation.

5242. (amended) The method of claim 5214, wherein the temperature sufficient to allow synthesis gas generation is in a range from approximately 400 °C to approximately 1200 °C.

5243. (amended) The method of claim 5214, wherein heating the first section to the temperature sufficient to allow synthesis gas generation comprises:

heating zones adjacent to wellbores of one or more of the heat sources with heaters disposed in the wellbores, wherein the heaters are configured to raise temperatures of the zones to temperatures sufficient to support reaction of hydrocarbon material in the zones with an oxidizing fluid;

introducing the oxidizing fluid to the zones substantially by diffusion;

allowing the oxidizing fluid to react with at least a portion of the hydrocarbon material in the zones to produce heat in the zones; and

transferring heat from the zones to the first section.

5244. (amended) The method of claim 5214, wherein heating the second section to the temperature sufficient to allow synthesis gas generation comprises:

heating zones adjacent to wellbores of one or more of the heat sources with heaters disposed in the wellbores, wherein the heaters are configured to raise temperatures of the zones to temperatures sufficient to support reaction of hydrocarbon material in the zones with an oxidizing fluid;

introducing the oxidizing fluid to the zones substantially by diffusion;

allowing the oxidizing fluid to react with at least a portion of the hydrocarbon material in the zones to produce heat in the zones; and

transferring heat from the zones to the second section.

ES 5245. (amended) The method of claim 5214, wherein heating the first section to the temperature sufficient to allow synthesis gas generation comprises:

introducing an oxidizing fluid to the formation through a wellbore;

transporting the oxidizing fluid substantially by convection to the first section, wherein the first section is at a temperature sufficient to support an oxidation reaction with the oxidizing fluid; and

reacting the oxidizing fluid in the first section to generate heat and raise the temperature of the first section.

5246. (amended) The method of claim 5214, wherein heating the second section to the temperature sufficient to allow synthesis gas generation comprises:

introducing an oxidizing fluid to the formation through a wellbore;

transporting the oxidizing fluid substantially by convection to the second section, wherein the second section is at a temperature sufficient to support an oxidation reaction with the oxidizing fluid; and

reacting the oxidizing fluid in the second section to generate heat and raise the temperature of the second section.

5247. (amended) The method of claim 5214, wherein at least one of the heat sources comprises an electrical heater disposed in the formation.

²⁵
5248. (amended) The method of claim 5214, wherein at least one of the heat sources comprises a natural distributor combustor.

²⁶
5249. (amended) The method of claim 5214, wherein the heat sources comprise one or more heater wells, wherein at least one of the heater wells comprises a conduit disposed in the formation, and further comprising heating the conduit by flowing a hot fluid through the conduit.

²⁷
5250. (amended) The method of claim 5214, wherein heating the first section to the temperature sufficient to allow synthesis gas generation and providing the first synthesis gas generating fluid to the first section comprises introducing steam to the first section.

ES ²⁸
5251. (amended) The method of claim 5214, wherein heating the second section to the temperature sufficient to allow synthesis gas generation and providing the second synthesis gas generating fluid to the second section comprises introducing steam to the second section.

²⁹
5252. (amended) The method of claim 5214, further comprising controlling the heating of the first section and provision of the first synthesis gas generating fluid to maintain a temperature in the first section above the temperature sufficient to generate synthesis gas.

³⁰
5253. (amended) The method of claim 5214, further comprising controlling the heating of the second section and provision of the second synthesis gas generating fluid to maintain a temperature in the second section above the temperature sufficient to generate synthesis gas.

EL ³¹
5259. (amended) The method of claim 5258, wherein a portion of the carbon dioxide in the first synthesis gas generating fluid comprises carbon dioxide removed from the formation.

EA ³²
5261. (amended) The method of claim 5260, wherein a portion of the carbon dioxide in the second synthesis gas generating fluid comprises carbon dioxide removed from the formation.

E8 5263. (amended) The method of claim 5262, wherein a portion of the carbon dioxide in the first synthesis gas generating fluid comprises carbon dioxide removed from the formation.

5265. (amended) The method of claim 5264, wherein a portion of the carbon dioxide in the second synthesis gas generating fluid comprises carbon dioxide removed from the formation.

E9 5266. (amended) The method of claim 5214, wherein providing the first synthesis gas generating fluid to the first section comprises raising a water table of the formation to allow water to flow to the first section.

5267. (amended) The method of claim 5214, wherein providing the second synthesis gas generating fluid to the second section comprises raising a water table of the formation to allow water to flow to the second section.

5268. (amended) The method of claim 5214, wherein the first synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons are subjected to a reaction in the first section to increase a H₂ concentration in the produced first synthesis gas.

E10 5270. (amended) The method of claim 5214, wherein the first synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react in the first section to increase an energy content of the produced first synthesis gas.

5271. (amended) The method of claim 5214, wherein the second synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react in at least the second section to increase an energy content of the second produced synthesis gas.

E10
5272. (amended) The method of claim 5214, further comprising maintaining a pressure in the formation during synthesis gas generation, and passing produced blended synthesis gas through a turbine to generate electricity.

5276. (amended) The method of claim 5214, further comprising using a portion of the first synthesis gas as a combustion fuel for one or more of the heat sources.

E11
5277. (amended) The method of claim 5214, further comprising using a portion of the second synthesis gas as a combustion fuel for one or more of the heat sources.

5278. (amended) The method of claim 5214, further comprising using a portion of the blended synthesis gas as a combustion fuel for one or more of the heat sources.

5279. (amended) A method of treating a coal formation in situ, comprising:
allowing heat to transfer from heaters to a part of the formation such that the heat from one or more of the heaters pyrolyzes some hydrocarbon material in the part of the formation;
producing pyrolysis products from the formation;
heating a first section of the formation with one or more of the heaters to a temperature sufficient to allow generation of synthesis gas;
providing a first synthesis gas generating fluid to the first section to generate a first synthesis gas;
removing a portion of the first synthesis gas from the formation;
heating a second section of a formation with one or more of the heaters to a temperature sufficient to allow generation of synthesis gas having a H₂ to CO ratio greater than a H₂ to CO ratio of the first synthesis gas;
providing a second synthesis gas generating fluid to the second section to generate a second synthesis gas;
removing a portion of the second synthesis gas from the formation; and
blending a portion of the first synthesis gas with a portion of the second synthesis gas to produce a blended synthesis gas having a selected H₂ to CO ratio.

⁶³5280. (amended) The method of claim ⁶²5279, wherein superposition of heat from at least two of the heaters pyrolyzes at least some hydrocarbons in the part of the formation.

E11 ⁶⁴5281. (amended) The method of claim ⁶⁵5279, wherein the first synthesis gas generating fluid and the second synthesis gas generating fluid comprise carbon dioxide.

⁶⁵5282. (amended) The method of claim ⁶²5279, further comprising controlling the temperature in the first section to control a composition of the first synthesis gas.

⁶⁶5283. (amended) The method of claim ⁶²5279, further comprising controlling the temperature in the second section to control a composition of the second synthesis gas.

E12 ⁶⁷5294. (amended) The method of claim ⁶²5279, wherein removing a portion of the second synthesis gas comprises withdrawing second synthesis gas through a production well, wherein a temperature of the production well adjacent to a production zone of the second synthesis gas is maintained at a substantially constant temperature such that the H₂ to CO ratio of the second synthesis gas is greater than the H₂ to CO ratio of the first synthesis gas.

⁶⁶5295. (amended) The method of claim ⁶²5279, wherein the first synthesis gas producing fluid comprises CO₂ and wherein the temperature of the first section is at a temperature that will result in conversion of CO₂ and carbon from the first section to CO to generate a CO rich first synthesis gas.

⁶⁹5296. (amended) The method of claim ⁶²5279, wherein the second synthesis gas producing fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons react in the formation to increase a H₂ concentration in the produced second synthesis gas.

E13 5298. (amended) The method of claim 5279, further comprising removing an excess of first synthesis gas from the first section to have an excess of CO, subjecting the first synthesis gas to a shift reaction to reduce an amount of CO and increase an amount of H₂ before blending the first synthesis gas with the second synthesis gas.

E14 5302. (amended) The method of claim 5279, further comprising generating electricity from the blended synthesis gas using a fuel cell, separating carbon dioxide from a fluid exiting the fuel cell, and storing a portion of the separated carbon dioxide in a spent section of the formation.

E15 5304. (amended) The method of claim 5279, wherein allowing the heat to transfer from the heaters to the part of the formation increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part is substantially uniform.

5305. (amended) The method of claim 5279, wherein allowing the heat to transfer from the heaters increases a permeability of a majority of the part to greater than about 100 millidarcy.

5306. (amended) The method of claim 5279, further comprising heating the first section when providing the first synthesis gas generating fluid to inhibit temperature decrease in the first section during synthesis gas generation.

5307. (amended) The method of claim 5279, wherein the temperature sufficient to allow synthesis gas generation is in a range from approximately 400 °C to approximately 1200 °C.

5308. (amended) The method of claim 5279, wherein heating the first section to the temperature sufficient to allow synthesis gas generation comprises:

heating zones adjacent to wellbores of one or more of the heaters with heaters disposed in the wellbores, wherein the heaters disposed in the wellbores are configured to raise temperatures of the zones to temperatures sufficient to support reaction of hydrocarbon material in the zones with an oxidizing fluid;

introducing the oxidizing fluid to the zones substantially by diffusion;

allowing the oxidizing fluid to react with at least a portion of the hydrocarbon material in the zones to produce heat in the zones; and
transferring heat from the zones to the first section.

⁹² 5309. (amended) The method of claim ⁶² ~~5279~~, wherein heating the second section to the temperature sufficient to allow synthesis gas generation comprises:

heating zones adjacent to wellbores of one or more of the heaters with heaters disposed in the wellbores, wherein the heaters disposed in the wellbores are configured to raise temperatures of the zones to temperatures sufficient to support reaction of hydrocarbon material in the zones with an oxidizing fluid;

introducing the oxidizing fluid to the zones substantially by diffusion;

allowing the oxidizing fluid to react with at least a portion of the hydrocarbon material in the zones to produce heat in the zones; and

transferring heat from the zones to the second section.

¹³ 5310. (amended) The method of claim ⁶² ~~5279~~, wherein heating the first section to the temperature sufficient to allow synthesis gas generation comprises:

introducing an oxidizing fluid to the formation through a wellbore;

transporting the oxidizing fluid substantially by convection to the first section, wherein the first section is at a temperature sufficient to support an oxidation reaction with the oxidizing fluid; and

reacting the oxidizing fluid in the first section to generate heat and raise the temperature of the first section.

¹⁴ 5311. (amended) The method of claim ⁶² ~~5279~~, wherein heating the second section to the temperature sufficient to allow synthesis gas generation comprises:

introducing an oxidizing fluid to the formation through a wellbore;

transporting the oxidizing fluid substantially by convection to the second section, wherein the second section is at a temperature sufficient to support an oxidation reaction with the oxidizing fluid; and

reacting the oxidizing fluid in the second section to generate heat and raise the temperature of the second section.

⁶²
5312. (amended) The method of claim ~~5279~~⁶², wherein at least one of the heaters comprises an electrical heater disposed in the formation.

⁶²
5313. (amended) The method of claim ~~5279~~⁶², wherein at least one of the heaters comprises a natural distributor combustor.

E15 ⁶²
5314. (amended) The method of claim ~~5279~~⁶², wherein the heaters comprise one or more heater wells, wherein at least one heater well comprises a conduit disposed in the formation, and further comprising heating the conduit by flowing a hot fluid through the conduit.

⁶²
5315. (amended) The method of claim ~~5279~~⁶², wherein heating the first section to the temperature sufficient to allow synthesis gas generation and providing the first synthesis gas generating fluid to the first section comprises introducing steam to the first section.

⁶²
5316. (amended) The method of claim ~~5279~~⁶², wherein heating the second section to the temperature sufficient to allow synthesis gas generation and providing the second synthesis gas generating fluid to the second section comprises introducing steam to the second section.

⁶²
5317. (amended) The method of claim ~~5279~~⁶², further comprising controlling the heating of the first section and provision of the first synthesis gas generating fluid to maintain a temperature in the first section above the temperature sufficient to generate synthesis gas.

⁶²
5318. (amended) The method of claim ~~5279~~⁶², further comprising controlling the heating of the second section and provision of the second synthesis gas generating fluid to maintain a temperature in the second section above the temperature sufficient to generate synthesis gas.

E16

¹⁰¹
5324. (amended) The method of claim ¹⁰⁸5323, wherein a portion of the carbon dioxide in the first synthesis gas generating fluid comprises carbon dioxide removed from the formation.

E17

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5326. (amended) The method of claim ¹⁰⁹5325, wherein a portion of the carbon dioxide in the second synthesis gas generating fluid comprises carbon dioxide removed from the formation.

E18

¹¹⁰
5328. (amended) The method of claim ¹¹⁰5327, wherein a portion of the carbon dioxide in the first synthesis gas generating fluid comprises carbon dioxide removed from the formation.

¹¹¹
5330. (amended) The method of claim ¹¹²5329, wherein a portion of the carbon dioxide in the second synthesis gas generating fluid comprises carbon dioxide removed from the formation.

E19

¹¹⁴
5331. (amended) The method of claim ¹⁰⁷5279, wherein providing the first synthesis gas generating fluid to the first section comprises raising a water table of the formation to allow water to flow to the first section.

¹¹⁵
5332. (amended) The method of claim ¹¹²5279, wherein providing the second synthesis gas generating fluid to the second section comprises raising a water table of the formation to allow water to flow to the second section.

¹¹⁶
5333. (amended) The method of claim ¹¹²5279, wherein the first synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons are subjected to a reaction in the first section to increase a H₂ concentration in the produced first synthesis gas.

E20

¹¹⁷
5335. (amended) The method of claim ¹¹²5279, wherein the first synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react in the first section to increase an energy content of the produced first synthesis gas.

^{11g}
5336. (amended) The method of claim ⁶²5279, wherein the second synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react in at least the second section to increase an energy content of the second produced synthesis gas.

E20
^{11a}
5337. (amended) The method of claim ⁶⁸5279, further comprising maintaining a pressure in the formation during synthesis gas generation, and passing produced blended synthesis gas through a turbine to generate electricity.

^{12g}
5341. (amended) The method of claim ⁶⁷5279, further comprising using a portion of the first synthesis gas as a combustion fuel for one or more of the heaters.

E21
¹²ⁱ
5342. (amended) The method of claim ⁶⁸5279, further comprising using a portion of the second synthesis gas as a combustion fuel for one or more of the heaters.

Discussion

A. Pending Claims

Claims 5214-5268, 5270-5272, 5276-5333, 5335-5337, and 5341-5343 are currently pending. Claims 5214-5218, 5227-5231, 5233, 5237, 5239-5253, 5266-5268, 5270-5272, 5276-5283, 5294-5296, 5298, 5302, 5304-5318, 5331-5333, 5335-5337, 5341, and 5342 have been amended. The claims have been amended for clarity and/or for correction of typographical errors. The claims have been amended so that the terms “part” and “section” are used in conjunction with the formation, while the term “portion” is used in conjunction with fluid. Claims 5269, 5273-5275, 5334, and 5338-5340 have been cancelled. The cancelled claims are potential duplicative claims.

B. Information Disclosure Statements

Applicant has not received a signed, initialed copy of Forms PTO-1449 (9 pages, including references A1-A256 and B1) submitted with the Information Disclosure Statement mailed on December 17, 2001 (postcard stamped received by the USPTO on January 3, 2002). Applicant respectfully requests a signed, initialed copy of the above-mentioned Forms PTO-1449. A copy of the originally filed Forms PTO-1449 noted above is enclosed for the Examiner's convenience.

C. Terminal Disclaimer

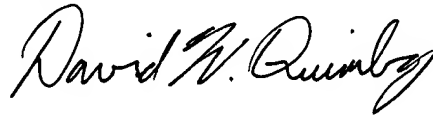
The Examiner requested a terminal disclaimer over co-pending application No. 09/841,311. Applicant does not believe that a terminal disclaimer is needed for the present application and application No. 09/841,311, but in the interest of expediency, a terminal disclaimer for the applications is being provided as a separate document.

D. Additional Comments

Applicant submits that all claims are in condition for allowance. Favorable reconsideration is respectfully requested.

Applicant believes that no fees are due with the submission of this response and accompanying documents. If an extension of time is required, Applicant hereby requests the appropriate extension of time. If any fees are required, please appropriately charge those fees to Meyertons, Hood, Kivlin, Kowert & Goetzel, P.C. Deposit Account Number 50-1505/5659-07400/EBM.

Respectfully submitted,



David W. Quimby
Reg. No. 39,338

Attorney for Applicant

MEYERTONS, HOOD, KIVLIN, KOWERT & GOETZEL, P.C.
P.O. Box 398
Austin, Texas 78767-0398
(512) 853-8800 (voice)
(512) 853-8801 (facsimile)

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